

Study of Water Pools on Runways Considering The ICAO and Brazilian Civil Aviation Agency Recommendations for Large Aircraft

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SUMMARY

- MOTIVATION
- INTRODUCTION
- AQUAPLANNING
- ICAO AND ANAC RECOMMENDATIONS ABOUT IDENTIFICATION OF WATER POOL IN AIRFIELD PAVEMENTS
- THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS
- CONCLUSIONS

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MOTIVATION

Accident	Victims	Nationalities
TAM 3054 - Congonhas Airport - 07/17/2007 (Regional FLIGHT)	187	Brazil (185), Peru (1) and Argentina (1)
MAS 17 - Near Grabove, Ukraine - 07/17/2014	298	Australia (27), Belgium (4), Canada (1), Germany (4), Indonesia (12), Malaysia (43), Netherlands (193), New Zealand (1), Philipines (3), United Kingdom (10)
Air Algérie 5017 - North of Mali - 07/24/2014	118	Algeria (6), Belgium (1), Burkina Faso (28), Cameroon (1), Canada (5), Egypt (1), France (52), Germany (4), Lebanon (6), Luxembourg (2), Mali (1), Nigeria (1), Spain (6), Switzerland (1), United Kingdom (1)
Bhoja Air 213 - Near Benazir Bhutto Int. Airport - 04/20/2012	127	Paquistan (126), USA (1)

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MOTIVATION

- Today, flights, even regional flights, have people from different countries. Thus, the issue of Airport Safety is a worldwide problem. Nowadays, on a regional flight between Sao Paulo and Brasilia it can be found people from different nationalities.
- Therefore, we believe that safety is something that affects us directly, even on the most distant airports in the world



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5

MOTIVATION



**TAM accident
Congonhas
Airport, Sao Paulo,
17/July/2007
People from 3
countries!**



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INTRODUCTION

- We have seen considerable changes in the mobility of the human being. If 60 years ago, a trip to another continent had to be planned a year before, today thousands of people daily perform this activity using various different transportation modes .
- Air transportation system is an indispensable part of the multimodal mobility, especially for longer than 1000 km distance.



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INTRODUCTION/AIM

- Many airport managers are still not prepared to meet the current aircraft operation demands.
- An example is the case of the International Airport of Belém (SBBE) in the northern region of Brazil where TAM airline canceled more than twenty flights in the beginning of 2014 due to the formation of water pools on the airfield pavements.
- This paper reviews and evaluates the International Aviation Organization (ICAO) and ANAC (Brazilian National Civil Aviation Agency) recommendations to the formation of water pools in Aerodrome Design and Operations. The paper discusses some improvements in pavement condition evaluation and maintenance management practice to assist airport managers.

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INTERNATIONAL AIRPORT OF BELÉM- PARÁ NORTH OF BRAZIL (BEL/SBBE)

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MAIN RUNWAY CLOSED A WEEK IN JANUARY/2014 BECAUSE OF THE FORMATION OF WATER POOL



AQUAPLANNING

- The effect of water in contact with wheel and the pavement results in denominated aquaplaning or hydroplaning. This effect has been studied in recent decades by numerous authors.
- Although appropriate actions often are taken on hot mix asphalt (HMA) pavements, aquaplaning can be triggered from anomalies arisen during the construction phase or even surface degradation generated by the action of traffic.



FORMATION OF A TRACK

During the construction of the upper HMA layer of asphalt pavement the formation of a track or groove at the junction of layers can occur in the longitudinal joint.



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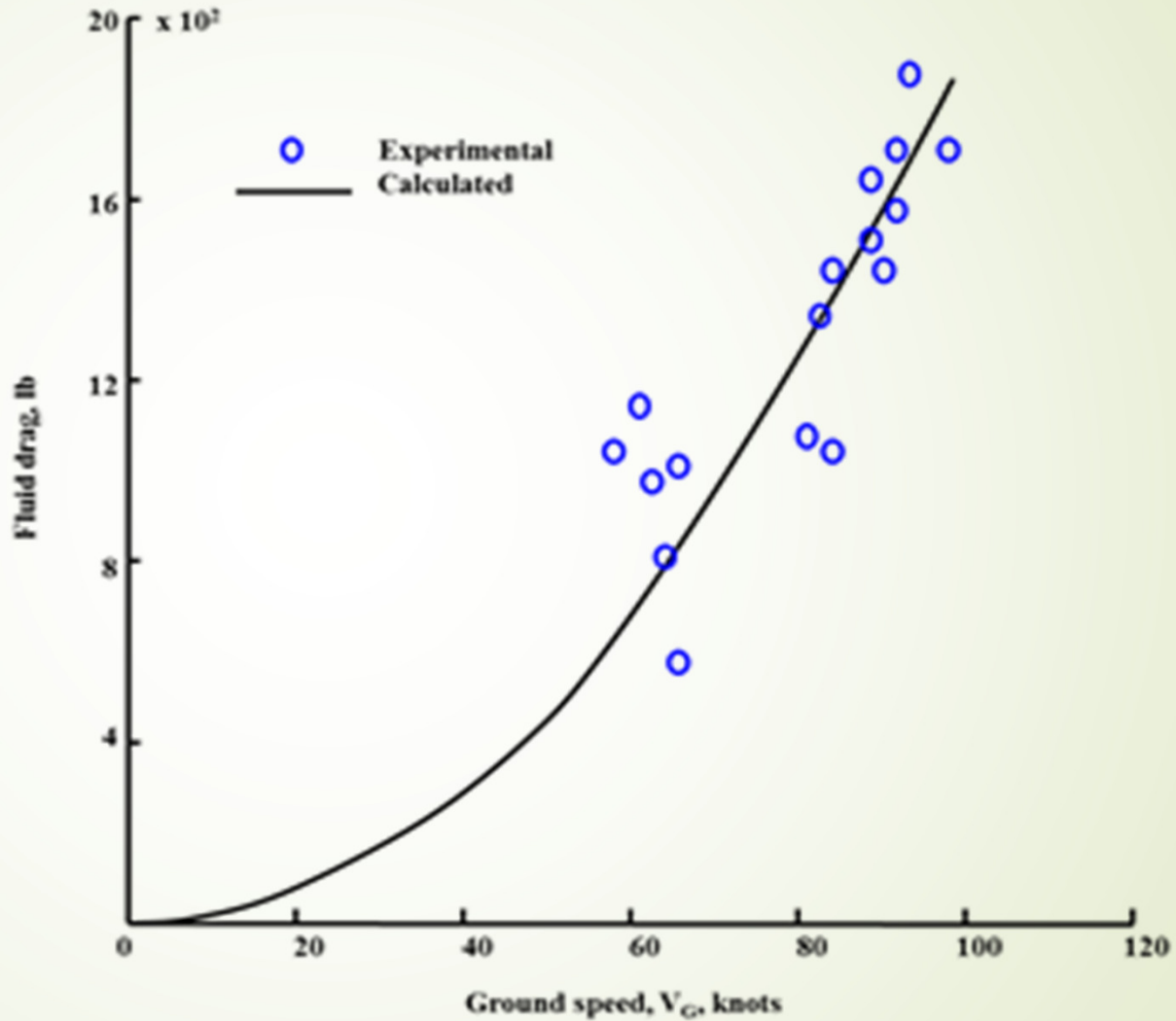
AQUAPLANNING

- One of the most alarming concerns of the aquaplaning phenomenon is the loss of drivability.
- A thin layer of water between the pavement and the tire can cause a complete contact loss with the pavement.
- Consequently, the loss of contact of the tires with pavement and the aircraft slide out of control and away from the centerline of the airfield.
- In the pioneering NASA research full scale experimental data was used to derive at limiting tire-hydroplaning velocities as a function of aircraft tires and pavement surface condition



AQUAPLANNING

Variation of Fluid (Slush) Drag with Ground Speed on Single Wheel, Tire Pressure, 350 lb/sq in (2413 kPa), (NASA)



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THE MAIN FACTORS THAT AFFECT THE AQUAPLANING

- Micro-texture and macro-texture;
- Water film thickness (WFT);
- Tire tread's depth and pattern;
- *Tire types;*
- *Tire size;*
- *Aircraft speed.*



ICAO AND ANAC RECOMMENDATIONS ABOUT IDENTIFICATION OF WATER POOL IN AIRFIELD PAVEMENTS

- The Brazil National Civil Aviation Agency (ANAC), which administers and regulates the operation of civil aviation in Brazil, has its own documents of procedures and national standards.
- However, these procedures and standards usually obey ICAO standard requirements.
- ANAC Agency do not present a specific document about the theme or a recommended regulation, when necessary, it regularly uses and references the ICAO Annex 14



ICAO AND ANAC RECOMMENDATIONS ABOUT IDENTIFICATION OF WATER POOL IN AIRFIELD PAVEMENTS

- item 5.5 of the Annex 14 the following information is available: “Runway damage with time may increase the possibility of the formation of water pools. Pools as shallow as approximately 3 mm in depth, particularly if they are located at places of high speed is common when landing airplanes, it might induce aquaplaning.”



ICAO AND ANAC RECOMMENDATIONS ABOUT IDENTIFICATION OF WATER POOL IN AIRFIELD PAVEMENTS

- ICAO document Doc 9137 AN 898 Airport Services Manual, Part 2, item 1.5.10 the following information is found: “Dynamic aquaplaning is experienced during the higher speeds of landing and take-off ground roll. As little as 0.5 mm of standing water has been found to be sufficient to support dynamic aquaplaning.”



ICAO AND ANAC RECOMMENDATIONS ABOUT IDENTIFICATION OF WATER POOL IN AIRFIELD PAVEMENTS

- In both documents the occurrence of water pool is related, **but the documents do not guide the airport managers about the formation of these pools or what would be possible to do for the pavement maintenance.** This is an important consideration in developing countries where **airport authorities may not always possess specialized technical personnel holding the position of airport manager**



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

- The ANAC Agency in Brazil recommends the measurement of the International Roughness Index (IRI) on airfield pavements and limits the value of the IRI to 1.0 (one meter per km);
- The document RBAC 153, item 153.2015e, mentions that if the average depth of water exceeds 3mm (three millimeters) in a length of 150m by the width of the airfield, the aerodrome operator must provide corrective actions



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

Longitudinal water pools in POA airport, south of Brazil



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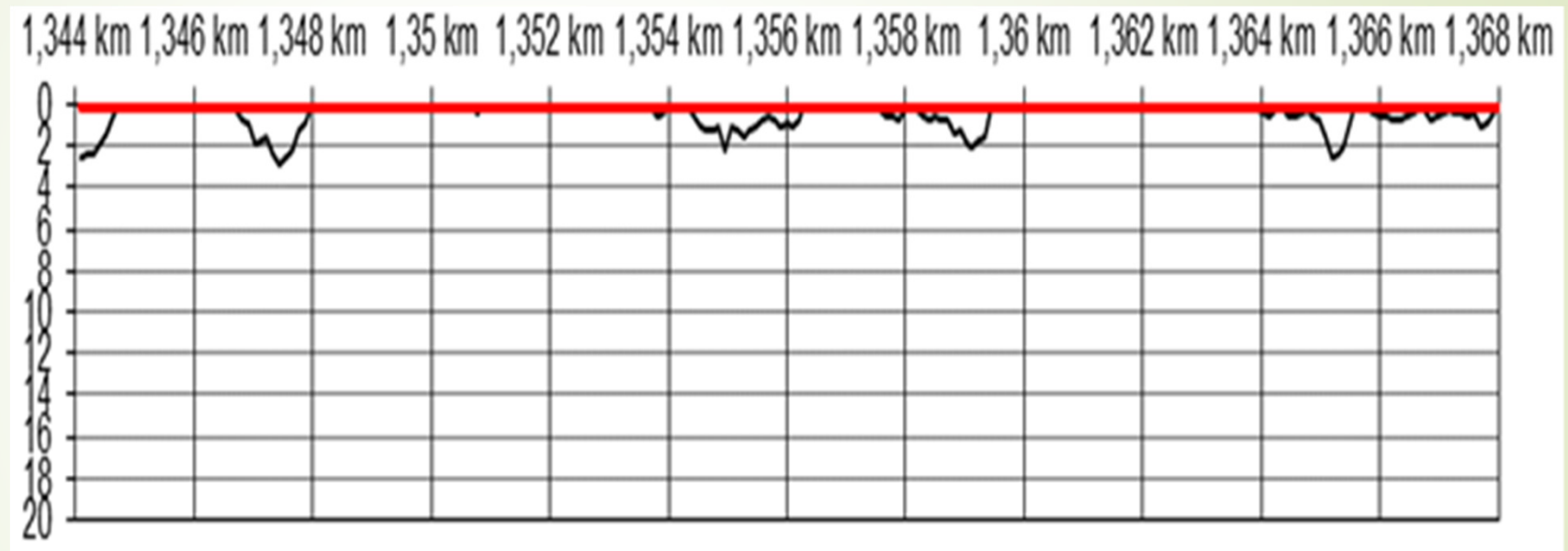


THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

- Both measures of longitudinal irregularities and average of water depth (water pools) must be done over the entire length of 3.0 m from the track axis on both sides of airfield;
- In the International Standards and Recommended Practices document, Aerodromes Annex 14, on item 3.1.14/15 f, there is only reference about the longitudinal slope change criteria



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS



Typical results of longitudinal Roughness



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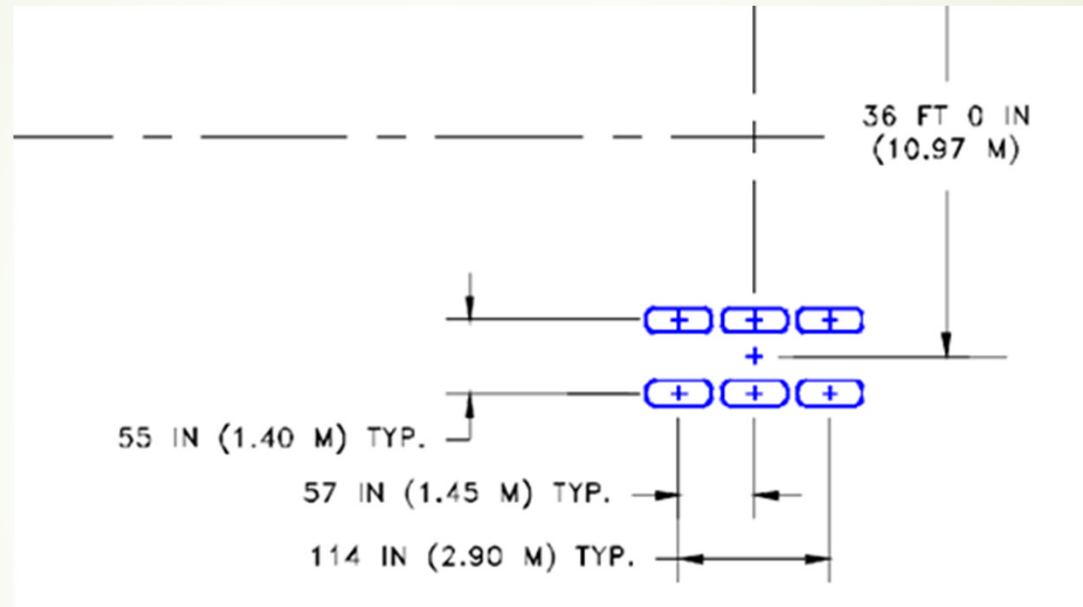


THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

Based on the experience of air fields in Brazil, the following recommendations and the limits are offered when considering the ICAO and ANAC recommendations related to the composition of the aircraft operations and the typical landing gear:



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS



NOT ONLY 3 m!!!! BUT 6 m too!!!



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

- Considering the case of only one runway or when the landing and take-off runway is the same, during the take-off, usually the aircraft crosses the runway on the centerline. There is a coverage concentration and as a result, permanent deformation may occur.
- The IRI must be measured 3m and 6m from the centerline considering the real aircraft traffic and the actual distance of the landing gear. For example, the actual landing gear distance from the centerline for a B777 aircraft [10] is around 4.78m (Figure 10).
- Additionally, the roughness must be measured transversely and at every 25m to detect if there are potential areas of water pools in the transverse sections.



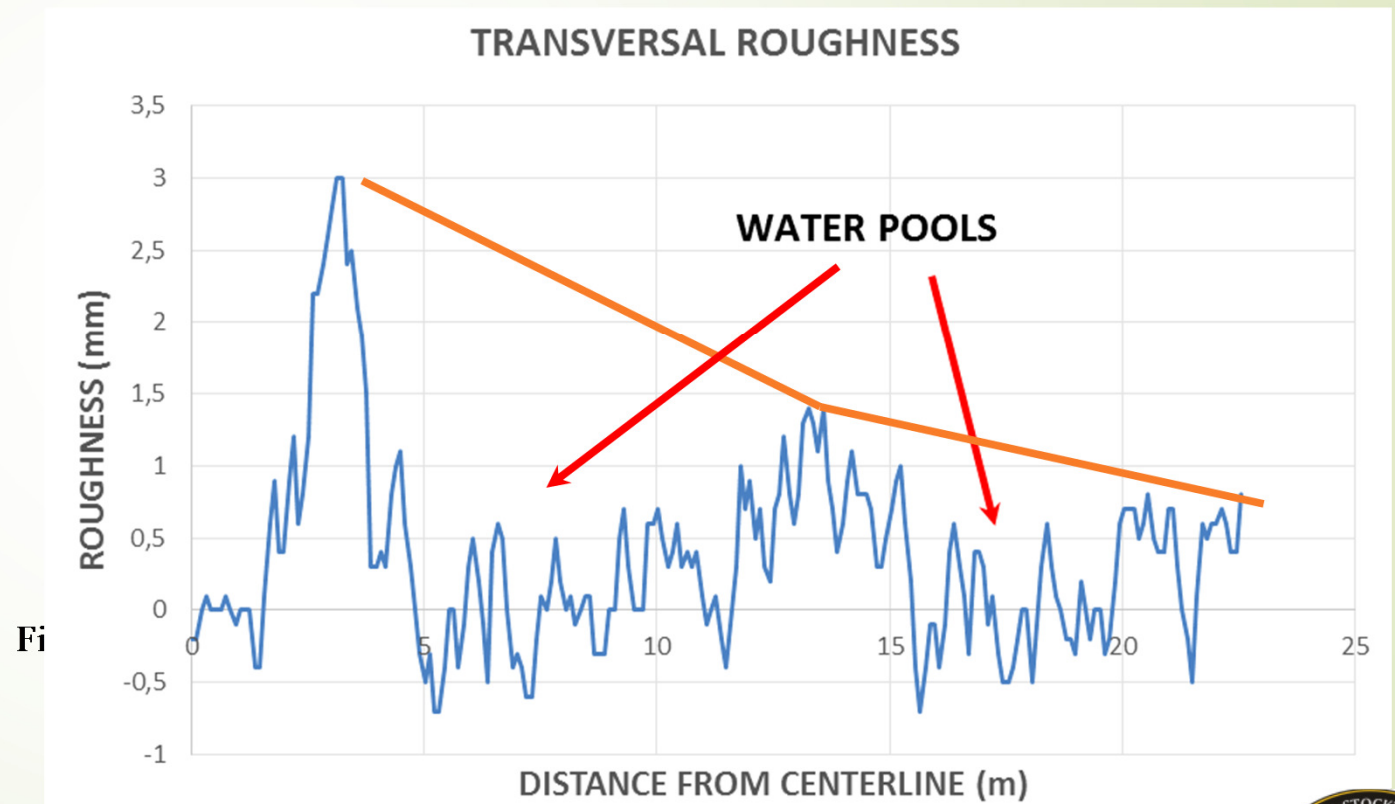
THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

- In summary, it is suggested to update/change the ICAO's and ANAC's standards taking into account the recommended IRI value limits and water Pools formation along the wheel path for large aircrafts.
- For ICAO and ANAC standards it is recommended that the IRI be measured within 3m from centerline and the main gear; and in case of large aircraft, this distance is around 6m.



THE IRI MEASUREMENT AS A TOOL TO IDENTIFY WATER POOLS

Transverse roughness showing two areas of water pools formation.



CONCLUSIONS

Considering that ICAO is a worldwide airport standard reference, especially for developing countries, it can be concluded that:

- 1) The ICAO must keep very clearly the information on how, where, frequency and levels of acceptance of the longitudinal roughness measurement for new and existing pavements.
- 2) The same action should be followed by ANAC. Brazil is among the ten largest economies in the world; however, the aerodrome standards for Brazilian airports still need improvements and updates.



CONCLUSIONS

- 3) Neither ANAC nor ICAO standards include references on how the airport operator must measure the existence of water pools or any guide on its measurement frequency.
- 4) The transverse roughness measured each 25m interval may help the airport manager to detect the formation of water pools.



MANY THANKS FOR YOUR ATTENTION

Waheed and Joao



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Save the date

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